B. Amendments to the Specification

Please replace the specification with the attached Substitute Specification. Applicants have provided a Substitute Specification, marked up to show the changes made, as well as a clean copy of the Substitute Specification for the Examiner's convenience.

A TREAD FOR A TIRE AND A TIRE COMPRISING IT

~~TIRE TREAD AND TIRE CONTAINING SAME~~

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention ~~concerns a tire~~relates to a tread for a tire and a tire ~~containing same~~comprising it. The invention applies~~, notably, in particular~~ to the ~~proper~~good operation of the electronic ~~devices loaded~~apparatus on board a vehicle ~~equipped~~fitted with such tires ~~and~~, in particular~~, on~~ a vehicle of the passenger ~~vehicle~~-car type. Thus, the invention applies~~,~~ for example~~,~~ to the quality of radio ~~-~~wave reception from a radio ~~set provided~~equipment inside such a vehicle~~,~~ and/or to the reliability of an electronic device provided inside a tire ~~equipping that~~fitted on this vehicle.

Related Art

[0002] It is known that the tires of a vehicle ~~are~~become charged and discharged by a triboelectric effect ~~on running~~when travelling, and that the corresponding ~~charge~~charging and ~~discharge~~discharging sometimes interfere, via electromagnetic disturbances, under ~~certain~~specific weather conditions, with the electronics ~~loaded~~ on board the vehicle, for example~~;~~ with ~~a~~ radio ~~set installed in~~equipment on board the vehicle, and more particularly when said ~~set~~equipment is used in amplitude ~~-~~modulation~~:~~ mode.

[0003] ~~What notably occurs, on~~In particular, when passing from a first ~~running~~ section of travel to a ~~following~~ second section ~~with~~of travel which succeeds it and which has different physical characteristics ~~different~~ from those of ~~said~~the first section, ~~such as a~~for example different ~~electric~~electrical conductivity and/or structure and/or relief, ~~is a~~ sudden ~~discharge by~~discharging via the tread of each tire of the charge accumulated on said first section ~~occurs~~.

[0004] Such successive ~~running~~ sections ~~can~~of travel may for example~~, consist~~ be formed respectively of an electrically insulating material, such as asphalt, and ~~of~~ an

electrically conductive material, such as thosethat used for metal joints of a bridge, for manhole covers or for railroadrailway rails.

[0005] It is also known that thosethese sudden discharges and the electromagnetic disturbances that canwhich may result therefrom are all the more marked, as the tread material is notably more, in particular, electrically insulating, upon passage from the first actual running is the material forming the tread, when passing during travel on one and the same first section to one and the same second actual section.

[0006] Now, it so happens that manya number of current tires are characterizedcharacterised by a high content of non-electrically conductive reinforcing filler, such as silica, with the intendeddesired advantageous effect of reducingwhich is to reduce the hysteresis losses during travel and, consequently, the rolling resistance of the tires, sosuch that the fuel consumption of the corresponding vehicle is likewisealso reduced.

[0007] One disadvantage of these tires resides inis the relatively high resistivity of the tread material; of the tread, the result of which is sometimes has the effect of generatingto generate said electromagnetic disturbancesdisturbance, under certain weather conditions.

SUMMARY OF THE INVENTION

[0008] The object of the present invention is to propose a tire tread for a tire and a tire containing samecomprising it, said tread, based on an electrically insulating material, being defined laterally defined by two sidewalls joininglateral faces connecting radially inner and outer faces together, which make it possible to minimise, onwhen passing from the said first section to the said second section, to minimize the energystrength of the electrostatic discharges offrom the tread of each tire and, therefore, to minimizeminimise the aforementioned electrostatic disturbances.

[0009] For that purpose, To this end, a tread for a tire tread according to the invention containscomprises on its circum-ferencecircumference at least one conductive layer appreciably joining the said sidewallssubstantially connecting said lateral faces together, said

layer having a resistivity ~~less~~lower than that of ~~the~~ said insulating material, which is provided on both sides of said ~~layer or of each~~ at least one layer in said tread.

[0010] This tread structure, ~~which is~~when used for a set of tires ~~equipping~~fitted on a vehicle with an ~~installed~~onboard radio receiver, makes it possible, ~~notably~~in particular, to reduce significantly the radio interference which ~~can~~may be ~~detected~~noticed in amplitude modulation~~, upon running over~~ mode, when travelling on electrically conductive road elements, under certain weather conditions.

[0011] According to a~~one~~ variant embodiment of the invention, ~~the said conductive layer or each~~ at least one conductive layer ~~appreciably joins the said sidewalls, so~~substantially connects said lateral faces together, such that it is interrupted opposite at least one of them.

[0012] According to another variant embodiment ~~of~~according to the invention, ~~the~~ said ~~conductive layer or each~~ at least one conductive layer ~~appreciably joins the said sidewalls,~~ ~~so~~substantially connects said lateral faces together, such that it is interrupted opposite said radially inner and outer faces.

[0013] According to another characteristic of the invention, ~~the~~ said ~~conductive layer or each~~ at least one conductive layer is ~~roughly~~substantially parallel to ~~the~~ said outer face.

[0014] According to another characteristic of the invention, ~~the~~ said tread ~~contains~~comprises a single conductive layer provided at a distance ~~away~~ from ~~both~~one and the other of said inner and outer faces which is greater than or equal to one-quarter of the thickness of said tread.

[0015] ~~Said~~Preferably, said distance is ~~preferably~~ equal to half the thickness of said tread.

[0016] ~~The~~Preferably, the resistivity of said conductive layer is ~~preferably~~made to be less than or equal to 10^{8} ~~Ω~~ Ω.cm, the resistivity of ~~the~~ said insulating material being made to be greater than or equal to 10^{8} ~~Ω~~ Ω.cm.

[0017] According to one particular embodiment of the invention, ~~the~~ said tread ~~further contains~~furthermore comprises at least one conductive film; which is provided to connect ~~the~~ said inner and outer faces ~~together~~ electrically.

[0018] ~~The~~Preferably, said tread then ~~preferably contains~~comprises two conductive films which are respectively provided ~~on~~at the locations of ~~the~~ said ~~sidewalls~~lateral faces.

[0019] ~~In~~Even more ~~preferably~~ for this embodiment, said films are ~~also preferably~~ extended respectively ~~over~~on said outer face by two electrically conductive circumferential peripheral bands.

[0020] According to a variant of this particular embodiment of the invention, ~~the~~ said tread ~~contains~~comprises, between said ~~sidewalls~~lateral faces, at least one electrically conductive film which connects said inner and outer faces together.

[0021] According to another variant of this particular embodiment of the invention, ~~the~~ said tread ~~contains, on one side~~comprises, firstly, at least one inner ~~ribbon conductor~~conductive strip connecting said ~~conductive layer or each~~ at least one conductive layer to said radially inner face and, ~~on the other~~furthermore, at least one ~~outer rubber conductor~~external conductive strip connecting said ~~conductive layer or each~~ at least one conductive layer to said radially outer face.

[0022] A tire according to the invention is ~~designed to contain~~such that it comprises said tread according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The ~~aforesaid~~aforementioned characteristics of the present invention, ~~as well as~~and others, will be better understood by reading the following description of ~~a working~~an example of embodiment of the invention, given by way of illustration ~~and without~~but not of limitation, said description ~~relating~~being given in relation to the ~~attached~~appended drawings, ~~among~~in which:

[0024] Fig. 1 is a diagram of a radial section of a tread according to a first embodiment of the invention,

[0025] Fig. 2 is a diagram of a radial section of a tread according to a second embodiment of the invention,

[0026] Fig. 1a is a schematic viewdiagram in radial section of a tread according to a first variant of said first embodiment of the invention,

[0027] Fig. 2a is a schematic viewdiagram in radial section of a tread according to a first variant of said second embodiment of the invention,

[0028] Fig. 1b is a diagram in radial section of a tread according to a second variant of said first embodiment of the invention,

[0029] Fig. 1a2b is a schematic viewdiagram in radial section of a tread according to a firstsecond variant of said firstsecond embodiment of the invention,

~~Fig. 2a is a schematic view in radial section of a tread according to a first embodiment of said second embodiment of the invention,~~

~~Fig. 1b is a schematic view in radial section of a tread according to a second variant of said first embodiment of the invention,~~

~~Fig. 2b is a schematic view in radial section of a tread according to a second variant of said second embodiment of the invention,~~

[0030] Fig. 2c is a schematic viewdiagram in radial section of a tread according to a third variant of said second embodiment of the invention,

[0031] Fig. 2d is a schematic viewdiagram in radial section of a tread according to a fourth variant of said second embodiment of the invention, and

[0032] Figs. 3, 4 and 5 are testexperimental graphs illustrating the sound level of the radio interference in amplitude -modulation mode which waswere detected under identical

conditions ~~on running, for travel~~ with tires ~~on~~with a conventional tread, ~~on~~with a tread according to Fig. 1 and ~~on~~with a tread according to Fig. ~~2.~~2 respectively.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The tread ~~represented~~1 illustrated in Fig. 1 ~~presents a roughly~~has a substantially trapezoidal radial section solely for purposes of simplification. It ~~is to~~will be understood that it could have any ~~shape deemed~~form judged appropriate, including tread patterns, ~~could be presented~~ for the type of tire ~~chosen~~selected.

[0034] This tread 1 is defined by a radially inner face ~~2~~2, intended to ~~lie opposite~~be located facing the different reinforcements of a tire (not ~~represented~~shown), by a radially outer face ~~3~~3, intended to ~~turn on~~evolve in contact with the ground when travelling, and by two ~~sidewalls~~lateral faces 4 and 5 connecting together the two ~~opposite~~facing pairs of lateral edges 6, 7 and 8, 9 of ~~the~~ said faces 2 and 3.

[0035] The tread 1 ~~has~~is based on an electrically insulating ~~base, consisting~~material, for example~~, of a nonconductive~~ one comprising a non-conductive reinforcing filler, such as silica.

[0036] As can be seen in the ~~example~~Example of Fig. 1, the tread 1 ~~contains~~comprises, on its ~~circumfer-ence~~circumference, a conductive layer 10 which ~~appreciably joins the said sidewalls 4 and 5, so~~substantially connects said lateral faces 4 and 5 together, such that the aforementioned insulating material is provided radially on both sides 11 and 12 of said layer 10.

[0037] In the example of Fig. 1, the tread 1 ~~contains~~comprises a single conductive layer 10 which is provided ~~roughly~~substantially parallel to ~~the~~ said outer face 3.

[0038] However, a tread 1 according to the invention ~~could contain~~might comprise a plurality of such conductive layers 10, ~~as long as~~provided that said insulating material is provided on both sides of each layer 10.

[0039] More specificallyprecisely, the conductive layer 10 inrelating to the example of Fig. 1 is situatedlocated at a distance away from either ofone or the other of said inner and outer faces 2, 3 which is preferably greater than or equal to one-quarter of the thickness of the tread 1.

[0040] As can be seen in this working exampleembodiment, said conductive layer 10 is, even more preferably placed, provided at an equal distance from said inner and outer faces 2 and 3.

[0041] It will be observednoted that a conductive layer 10 according to the invention is characterizedcharacterised by alower resistivity less than that of the zone 13 occupied by said insulating material, in the tread 1.

[0042] By way of example, the resistivity of said conductive layer 10 is designedarranged to be less than or equal to 10^8 Ω Ω.cm, whilewhereas the resistivity of said insulating material is intendedarranged to be greater than or equal to 10^8 Ω Ω.cm.

[0043] The conductive layer 10 consists,is for example, of an elastomer compound formed of a mix of elastomers which is filled with carbon black, the content of carbon black content being determined byset according to the desired resistivity sought.

[0044] According to a variant embodiment of thatthis conductive layer 10, it canmay be obtained from a liquid solution which is applied ontoto one of the parts 11, 12 of the tread 1, said solution comprising an electrically conductive compoundmix and a dilutiondiluting solvent.

[0045] Furthermore, said conductive layer 10 canmay have a variable thickness compared towith that of the tread, for example advantageously ranging, for example,of between 0.5 mm and 2.5 mm, for a total thickness of the tread 1 averaging aroundof about 1.2 cm on average.

[0046] Tests were conductedperformed with tires, each containingcomprising a tread 1 of the type illustrated in Fig. 1, 1, as discussed below in the Examples.

[0047] They revealed, insideThus, within a vehicle equipped with a radio receiver operating onin amplitude -modulation mode and tested while travelingtravelling on a road containingcomprising metal sections, such as manhole coversmanholes and/or metal bridge joints, there is exhibited a significant reduction ofin the electrostatic discharge onwhen entering thosethese sections and, consequently, ofin the radio interference which can be detected, under certain weather conditions.

[0048] ThisThere results in a notablea significant improvement in the listening conveniencecomfort for the passengers.

[0049] Fig. 2 illustratesshows a second embodiment of the tread 1 of Fig. 1, the elements of samethereof which are repeated identically repeated there being respectively identified, respectively, by numericalnumbered references increased by 100.

[0050] A tread 101 according to Fig. 2 is distinguished from said tread 1 in that it further containsfurthermore comprises at least one radial conductive film 114 which is provided to make an electric connection of electrically connect the outer face 103 to the inner face 102 of the said tread 101.

[0051] In the working example of embodiment of Fig. 2, it can be seen that the tread 101 containscomprises two conductive films 114 which are respectively provided onat the locations of the sidewallslateral faces 104 and 105 of said tread 101 and which are, preferably, are extended respectively overon said outer face 103 by two circumferential peripheral bands 115, likewisewhich are also conductive and of variable width.

[0052] It is towill be noted that thethese conductive films 114 canmay have a different thickness different from that of the said conductive layer 110.

[0053] As for the resistivity of said films 114, it is preferably roughlysubstantially equal to that of said layer 110 in this working example of embodiment.

[0054] Tests were also conductedcarried out with tires each containingcomprising a tread 101 of this type, thus revealingas discussed below in the Examples, and thus there was displayed a significant reduction of theirin electrostatic discharge onwhen entering the aforementioned sections referredwith reference to in the working example of embodiment of Fig. 1 and also a significant reduction of the possiblein any radio interference resultingwhich results therefrom.

[0055] With referenceReferring to the working examples of embodiment which have just been described, it is towill be observednoted that the treads 1, 101 according to the invention further reduce the hysteresis losses offurthermore impart to the tires incorporating them reduced hysteresis losses during travel, in the same way as a tread withbased on the same insulating material base includingcomprising a low-hysteresis reinforcing filler, such as silica.

[0056] It is towill also be further noted that the axial conductive layers 10, 110 according toof Figs. 1 and 2 do not, each in practice, each present have a strictly linear radial section like the one schematically representedas is indicated diagrammatically, but a more ofor less irregular section resulting, which results from the pressure stresses inherent to moldingin the moulding of the tire. Each conductive layer 10, 110 couldmight, for example, presenthave a radial section that is appreciably rippledwhich is substantially undulating, or in the form of broken lines, provided that it extends between the said sidewallslateral faces 4, 104 and 5, 105 and over the entire circumference of the tire incorporating it.

[0057] Figs. 1a and 1b, on the one hand, and Figs. 2b, 2c and 2d, on the other hand, illustrate variant embodiments of the treads representedshown in Figs. 1 and 22, respectively, the elements of those inthese Figs. 1a, 1b, 2b, 2c and 2d which fulfillperform functions similar to those of the elements inof Figs. 1 and 2 being identified by the same numerical references.

[0058] The treads 1 of Figs. 1a and 1b, like thatfollowing the example of Fig. 1, are also so designedsuch that the conductive layer 10 which each of them contains appreciablycomprises substantially connects the said sidewallslateral faces 4 and 5.5 together.

[0059] More specificallyprecisely, the layer 10 of Fig. 1a is interrupted opposite each of the sidewallslateral faces 4 and 5 of the tread 1, that is, to say that each of the lateral edges 10a, 10b of said layer 10 is awaydistant from the opposite sidewalllateral opposing face 4 or 5.

[0060] Without limitationIn non-limitative manner, each edge 10a, 10b canmay be separateddistant from the lateral face 4 or 5 opposite sidewall 4 or 5 by a distance equal,which may for example, to equal 5% of the width of the tread 1 on1, at the sitelocation of said layer 10.

[0061] It is towill be noted that in such a layer 10 according to thata layer 10 in accordance with this variant embodiment might be such that only one of its lateral edges 10a or 10b might beis distant from the opposite sidewalllateral face 4 or 5.5 opposite.

[0062] As for the layer 10 of Fig. 1b, it differsis distinguished from that of Fig. 1a in that it is furtherfurthermore interrupted opposite the said inner and outer faces 2 and 3 of the tread 1, that is, to say that it has between its edges 10a and 10b it presents a plurality of interruptions 10c in the form of circumferential grooves.

[0063] The treads 101 of Figs. 2a to 2d, like thatfollowing the example of Fig. 2, are also so designedsuch that the conductive layer 110 which each of them contains appreciably joins the said sidewalls 104 and 105. It is tocomprises substantially connects said lateral faces 104 and 105 together. It will be understood that a tread 101 according to one of thosethese Figs. 2a to 2d could,might for example, be so designedsuch that the conductive layer 110 it contains responds towhich it comprises meets the aforementioned description relatingwith reference to Figs. 1a and 1b.

[0064] More specificallyprecisely, the tread 101 of Fig. 2a differs from that of Fig. 2 in that it comprises between its sidewallslateral faces 104 and 105, instead of the said films 114, it contains two conductive films 114' which electrically connect the inner and outer faces 102 and 103 of the said tread 101.101 together.

[0065] ThoseThese two films 114' are in this example are symmetrical to each other in relationrelative to the circumferential median plane P of thatthis tread 101.

[0066] It is towill be noted that a tread 101 according toin accordance with this variant embodiment could containmight comprise more than two conductive films 114', and that each film 114' couldmight have a given inclination other than that representedshown in Fig. 2a in relation, relative to the said circumferential median plane P.

[0067] As for the tread 101 of Fig. 2c, it differs from that of Fig. 2a, in that it comprises between its sidewallslateral faces 104 and 105 it contains a single conductive film 114' joining thewhich connects said faces 102 and 103,103 together, in this example provided in that example onat the sitelocation of said median plane P.

[0068] The tread 101 of Fig. 2b differs from that of Fig. 2,2 in that it contains, on one sidecomprises, firstly, two inner ribbon conductorsconductive strips 114a which are provided respectively provided onat the siteslocations of said sidewallslateral faces 104 and 105 and which connect said conductive layer 110 to said inner face 102 and, on the othersecondly, an outer ribbon conductorconductive strip 114b which is provided between the said sidewallslateral faces 104 and 105 and which connects said layer 110 to said outer face 105 *[sic]*.105.

[0069] In the example of Fig. 2b, said outer ribbon conductorstrip 114b is provided onat the sitelocation of said circumferential median plane P.

[0070] It is towill however be noted, however, that a tread 101 according to thatin accordance with this variant embodiment could containmight comprise one or more outer ribbon conductorsstrips 114b, each capable ofpossibly having a different geometry and an inclination different from said plane P, provided that it connects said layer 110 to said outer face 105 *[sic]*.105.

[0071] As for the tread 101 of Fig. 2d, it also contains an outer ribbon conductor 114b likecomprises an external strip 114b such as that of Fig. 2b, but it differs from that of Fig. 2b in that it contains only onecomprises a single inner ribbon conductorstrip 114

~~connectingwhich connects~~ said inner face 102 to said conductive layer 110, said inner ~~ribbon conductors~~strip 114a being provided between ~~the~~ said ~~sidewalls~~lateral faces 104 and 105.

~~[0072]~~ It ~~is to~~will be noted that ~~those~~these conductive films 114' and ~~those ribbon conductors~~strips 114a and 114b ~~can~~may have a ~~thickness~~ different thickness from that of said ~~conductive layer~~ or ~~of~~ each conductive layer 110.

~~[0073]~~ As for the resistivity of said films 114' and said ~~ribbon conductors~~strips 114a and 114b, it is preferably ~~roughly~~substantially equal to that of said layer 110 in ~~those~~these variant embodiments.

EXAMPLES

~~[0074]~~ ~~Here is an~~An account will now be given of ~~the~~ tests ~~performed, on the one hand,~~ ~~on~~carried out, firstly, with a first set of tires ~~with~~having a tread 1 according to Fig. 1 and, ~~on the other, on~~secondly, with a second set of tires ~~with~~having a tread 101 according to Fig. 2. ~~Those~~These tests were ~~conducted~~performed in comparison with a ~~“”~~“control”” set of tires, ~~characterized~~which is characterised by an insulating tread~~, of~~ having a resistivity greater than or equal to 10^{13} ~~Ω~~ Ω.cm.

~~[0075]~~ ~~Those~~These tests consisted ~~of~~in quantifying the radio interference detected in amplitude ~~=~~modulation mode, ~~on~~during the travel of a test vehicle provided successively ~~fitted~~ with ~~those~~these sets of tires, by amplification and analysis of the corresponding ~~signals~~ recorded signals on a loudspeaker.

~~[0076]~~ ~~Those~~These tests were ~~conducted~~carried out under the same weather conditions (temperature ~~17°C, outdoor humidity level 18%, outdoor dew point temperature -7°C~~; 17°C, moisture content of the external air: 18%, dewpoint temperature of the external air: -7°C) and under the same ~~running~~travelling conditions (road sections ~~containing~~comprising manhole covers, ~~running~~travelling speed: 70 km/h).

~~[0077]~~ Furthermore, ~~a frequency of 1386 kHz~~there was used for the radio receiver ~~installed~~ on board the test vehicle a frequency of 1386 kHz, corresponding to amplitude

modulation, with the same amplification of the signal emitted byfrom the radio receiver infor all the tests.

[0078] The tires of each of the sets tested had a tread approximatelyof a thickness of about 1.2 cm thick. As forRelating to the tires withhaving a tread 1, 101 according to the invention, belonging which are relative to thesaid first and second sets, each axial conductive layer 10, 110 had a thickness of 0.5 mm and a resistivity roughlysubstantially equal to 10^3 Ω.cm.

[0079] With regardRelating to the tread 101 of the tires of said second set, boththe two radial conductive layers 114 had, for example, had a thickness of 0.5 mm, and a resistivity alsowhich is likewise less than or equal to 10^3 Ω.cm.

[0080] As for the resistivity of the said insulating material of each tread 1, 101, it was made equal to that of each tread of the said ""control"" set, that is to say, greater than or equal to 10^{13} Ω.cm.

[0081] The test results of these tests are illustrated by the graphs of Figs. 3, 4 and 5, which refer respectively to the said ""control"" set, to said first set and to said second set of tires, and which represent averagesaverage values, over several runs, of the potential of the signal recorded in amplitude modulation mode (expressed in V) as a function of time (expressed in ms).

[0082] It can be seen in Fig. 3 that, for the ""control"" set of tires, runningthe travelling of the vehicle onover the metal elements generates onat the loudspeaker meanaverage values of interference values of relatively high amplitudes (1.62 V and 1.79 V respectively V, for the pairs of front and rear pairs of tires respectively). Those meanThese average potential values, called "V_{ms}"referred to as "V_{rms}" by the expertperson skilled in the art, are calculated by means of discrete quadraticroot mean onsquare over an acquisition time window.

[0083] As can be seen in Fig. 4, the first set of tires according to the invention itself generates meanaverage interference values V_{ms} V_{rms}, the amplitudes of which are very

appreciablysubstantially reduced relative to thecompared with said ""control[22]" set (0.66 V and 0.72 V), for the pairs of front and rear pairs of tires respectively, theor a reduction being approximatelyof about 60%).

[0084] As can be seen in Fig. 5, the second set of tires according to the invention generates meanaverage interference values V_{ms} V_{rms}, the amplitudes of which are further reduced relative tostill further compared with said first set (0.16 V and 0.21 V), for the pairs of front and rear pairs of tires respectively, theor a reduction being approximatelyof about 90%).

[0085] As can be seen in Figs. 4 and 5, it is towill be noted that the duration of each interference phenomenon relative to said first and second sets of tires is also considerablylikewise substantially reduced, compared relative to the ""control[22]" set.

[0086] In conclusion, the result of these tests is a listening convenienceshows satisfactory tolistening comfort for the passenger or passengers ofin a vehicle which is equipped with tires according to the invention.

TITLE

A TREAD FOR A TIRE AND A TIRE COMPRISING IT

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a tread for a tire and a tire comprising it. The invention applies in particular to the good operation of the electronic apparatus on board a vehicle fitted with such tires, in particular a vehicle of the passenger-car type. Thus, the invention applies for example to the quality of radio-wave reception from radio equipment inside such a vehicle, and/or to the reliability of an electronic device provided inside a tire fitted on this vehicle.

Related Art

[0002] It is known that the tires of a vehicle become charged and discharged by a triboelectric effect when travelling, and that the corresponding charging and discharging sometimes interfere, via electromagnetic disturbances, under specific weather conditions, with the electronics on board the vehicle, for example with radio equipment on board the vehicle, and more particularly when said equipment is used in amplitude-modulation mode.

[0003] In particular, when passing from a first section of travel to a second section of travel which succeeds it and which has different physical characteristics from those of the first section, for example different electrical conductivity and/or structure and/or relief, sudden discharging via the tread of each tire of the charge accumulated on said first section occurs.

[0004] Such successive sections of travel may for example be formed respectively of an electrically insulating material, such as asphalt, and an electrically conductive material, such as that used for metal joints of a bridge, manhole covers or railway rails.

[0005] It is also known that these sudden discharges and the electromagnetic disturbances which may result therefrom are all the more marked, the more, in particular, electrically insulating is the material forming the tread, when passing during travel on one and the same first section to one and the same second section.

[0006] Now, it happens that a number of current tires are characterised by a high content of non-electrically conductive reinforcing filler, such as silica, the desired advantageous effect of which is to reduce the hysteresis losses during travel and, consequently, the rolling resistance of the tires, such that the fuel consumption of the corresponding vehicle is also reduced.

[0007] One disadvantage of these tires is the relatively high resistivity of the material of the tread, the result of which is sometimes to generate said electromagnetic disturbance, under certain weather conditions.

SUMMARY OF THE INVENTION

[0008] The object of the present invention is to propose a tread for a tire and a tire comprising it, said tread, based on an electrically insulating material, being defined laterally by two lateral faces connecting radially inner and outer faces together, which make it possible to minimise, when passing from said first section to said second section, the strength of the electrostatic discharges from the tread of each tire and therefore to minimise the aforementioned electrostatic disturbances.

[0009] To this end, a tread for a tire according to the invention comprises on its circumference at least one conductive layer substantially connecting said lateral faces together, said layer having a resistivity lower than that of said insulating material, which is provided on both sides of said at least one layer in said tread.

[0010] This tread structure, when used for a set of tires fitted on a vehicle with an onboard radio receiver, makes it possible, in particular, to reduce significantly the radio interference which may be noticed in amplitude modulation mode, when travelling on electrically conductive road elements, under certain weather conditions.

[0011] According to one variant embodiment of the invention, said at least one conductive layer substantially connects said lateral faces together, such that it is interrupted opposite at least one of them.

[0012] According to another variant embodiment according to the invention, said at least one conductive layer substantially connects said lateral faces together, such that it is interrupted opposite said radially inner and outer faces.

[0013] According to another characteristic of the invention, said at least one conductive layer is substantially parallel to said outer face.

[0014] According to another characteristic of the invention, said tread comprises a single conductive layer provided at a distance from one and the other of said inner and outer faces which is greater than or equal to one-quarter of the thickness of said tread.

[0015] Preferably, said distance is equal to half the thickness of said tread.

[0016] Preferably, the resistivity of said conductive layer is made to be less than or equal to 10^8 Ω.cm, the resistivity of said insulating material being made to be greater than or equal to 10^8 Ω.cm.

[0017] According to one particular embodiment of the invention, said tread furthermore comprises at least one conductive film which is provided to connect said inner and outer faces together electrically.

[0018] Preferably, said tread then comprises two conductive films which are respectively provided at the locations of said lateral faces.

[0019] Even more preferably for this embodiment, said films are extended respectively on said outer face by two electrically conductive circumferential peripheral bands.

[0020] According to a variant of this particular embodiment of the invention, said tread comprises, between said lateral faces, at least one electrically conductive film which connects said inner and outer faces together.

[0021] According to another variant of this particular embodiment of the invention, said tread comprises, firstly, at least one inner conductive strip connecting said at least one conductive layer to said radially inner face and, furthermore, at least one external conductive strip connecting said at least one conductive layer to said radially outer face.

[0022] A tire according to the invention is such that it comprises said tread according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The aforementioned characteristics of the present invention, and others, will be better understood by reading the following description of an example of embodiment of the invention, given by way of illustration but not of limitation, said description being given in relation to the appended drawings, in which:

[0024] Fig. 1 is a diagram of a radial section of a tread according to a first embodiment of the invention,

[0025] Fig. 2 is a diagram of a radial section of a tread according to a second embodiment of the invention,

[0026] Fig. 1a is a diagram in radial section of a tread according to a first variant of said first embodiment of the invention,

[0027] Fig. 2a is a diagram in radial section of a tread according to a first variant of said second embodiment of the invention,

[0028] Fig. 1b is a diagram in radial section of a tread according to a second variant of said first embodiment of the invention,

[0029] Fig. 2b is a diagram in radial section of a tread according to a second variant of said second embodiment of the invention,

[0030] Fig. 2c is a diagram in radial section of a tread according to a third variant of said second embodiment of the invention,

[0031] Fig. 2d is a diagram in radial section of a tread according to a fourth variant of said second embodiment of the invention, and

[0032] Figs. 3, 4 and 5 are experimental graphs illustrating the sound level of the radio interference in amplitude-modulation mode which were detected under identical conditions, for travel with tires with a conventional tread, with a tread according to Fig. 1 and with a tread according to Fig. 2 respectively.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The tread 1 illustrated in Fig. 1 has a substantially trapezoidal radial section solely for purposes of simplification. It will be understood that it could have any form judged appropriate, including tread patterns, for the type of tire selected.

[0034] This tread 1 is defined by a radially inner face 2, intended to be located facing the different reinforcements of a tire (not shown), by a radially outer face 3, intended to evolve in contact with the ground when travelling, and by two lateral faces 4 and 5 connecting together the two facing pairs of lateral edges 6, 7 and 8, 9 of said faces 2 and 3.

[0035] The tread 1 is based on an electrically insulating material, for example one comprising a non-conductive reinforcing filler, such as silica.

[0036] As can be seen in the Example of Fig. 1, the tread 1 comprises, on its circumference, a conductive layer 10 which substantially connects said lateral faces 4 and 5 together, such that the aforementioned insulating material is provided radially on both sides 11 and 12 of said layer 10.

[0037] In the example of Fig. 1, the tread 1 comprises a single conductive layer 10 which is provided substantially parallel to said outer face 3.

[0038] However, a tread 1 according to the invention might comprise a plurality of such conductive layers 10, provided that said insulating material is provided on both sides of each layer 10.

[0039] More precisely, the conductive layer 10 relating to the example of Fig. 1 is located at a distance from one or the other of said inner and outer faces 2, 3 which is preferably greater than or equal to one-quarter of the thickness of the tread 1.

[0040] As can be seen in this embodiment, said conductive layer 10 is, even more preferably, provided at an equal distance from said inner and outer faces 2 and 3.

[0041] It will be noted that a conductive layer 10 according to the invention is characterised by lower resistivity than that of the zone 13 occupied by said insulating material, in the tread 1.

[0042] By way of example, the resistivity of said conductive layer 10 is arranged to be less than or equal to 10^8 Ω.cm, whereas the resistivity of said insulating material is arranged to be greater than or equal to 10^8 Ω.cm.

[0043] The conductive layer 10 is for example formed of a mix of elastomers which is filled with carbon black, the content of carbon black being set according to the desired resistivity.

[0044] According to a variant embodiment of this conductive layer 10, it may be obtained from a liquid solution which is applied to one of the parts 11, 12 of the tread 1, said solution comprising an electrically conductive mix and a diluting solvent.

[0045] Furthermore, said conductive layer 10 may have a variable thickness compared with that of the tread, for example advantageously of between 0.5 mm and 2.5 mm, for a total thickness of the tread 1 of about 1.2 cm on average.

[0046] Tests were performed with tires each comprising a tread 1 of the type illustrated in Fig. 1, as discussed below in the Examples.

[0047] Thus, within a vehicle equipped with a radio receiver operating in amplitude-modulation mode and tested travelling on a road comprising metal sections, such as manholes and/or metal bridge joints, there is exhibited a significant reduction in the electrostatic discharge when entering these sections and, consequently, in the radio interference which can be detected, under certain weather conditions.

[0048] There results a significant improvement in the listening comfort for the passengers.

[0049] Fig. 2 shows a second embodiment of the tread 1 of Fig. 1, the elements thereof which are repeated identically being identified, respectively, by numbered references increased by 100.

[0050] A tread 101 according to Fig. 2 is distinguished from said tread 1 in that it furthermore comprises at least one radial conductive film 114 which is provided to electrically connect the outer face 103 to the inner face 102 of said tread 101.

[0051] In the example of embodiment of Fig. 2, it can be seen that the tread 101 comprises two conductive films 114 which are respectively provided at the locations of the lateral faces 104 and 105 of said tread 101 and which, preferably, are extended respectively on said outer face 103 by two circumferential peripheral bands 115, which are also conductive and of variable width.

[0052] It will be noted that these conductive films 114 may have a different thickness from that of said conductive layer 110.

[0053] As for the resistivity of said films 114, it is preferably substantially equal to that of said layer 110 in this example of embodiment.

[0054] Tests were also carried out with tires each comprising a tread 101 of this type, as discussed below in the Examples, and thus there was displayed a significant reduction in electrostatic discharge when entering the aforementioned sections with reference to the example of embodiment of Fig. 1 and also a significant reduction in any radio interference which results therefrom.

[0055] Referring to the examples of embodiment which have just been described, it will be noted that the treads 1, 101 according to the invention furthermore impart to the tires incorporating them reduced hysteresis losses during travel, in the same way as a tread based on the same insulating material comprising a low-hysteresis reinforcing filler, such as silica.

[0056] It will also be noted that the axial conductive layers 10, 110 of Figs. 1 and 2 do not each in practice have a strictly linear radial section as is indicated diagrammatically, but a more or less irregular section, which results from the pressure stresses inherent in the moulding of the tire. Each conductive layer 10, 110 might, for example, have a radial section which is substantially undulating, or in the form of broken lines, provided that it extends between said lateral faces 4, 104 and 5, 105 and over the entire circumference of the tire incorporating it.

[0057] Figs. 1a and 1b on one hand, and Figs. 2b, 2c and 2d on the other hand, illustrate variant embodiments of the treads shown in Figs. 1 and 2, respectively, the elements of these Figs. 1a, 1b, 2b, 2c and 2d which perform functions similar to those of the elements of Figs. 1 and 2 being identified by the same numerical references.

[0058] The treads 1 of Figs. 1a and 1b, following the example of Fig. 1, are also such that the conductive layer 10 which each of them comprises substantially connects said lateral faces 4 and 5 together.

[0059] More precisely, the layer 10 of Fig. 1a is interrupted opposite each of the lateral faces 4 and 5 of the tread 1, that is to say that each of the lateral edges 10a, 10b of said layer 10 is distant from the lateral opposing face 4 or 5.

[0060] In non-limitative manner, each edge 10a, 10b may be distant from the lateral face 4 or 5 opposite by a distance which may for example equal 5% of the width of the tread 1, at the location of said layer 10.

[0061] It will be noted that a layer 10 in accordance with this variant embodiment might be such that only one of its lateral edges 10a or 10b is distant from the lateral face 4 or 5 opposite.

[0062] As for the layer 10 of Fig. 1b, it is distinguished from that of Fig. 1a in that it is furthermore interrupted opposite said inner and outer faces 2 and 3 of the tread 1, that is to say that it has between its edges 10a and 10b a plurality of interruptions 10c in the form of circumferential grooves.

[0063] The treads 101 of Figs. 2a to 2d, following the example of Fig. 2, are also such that the conductive layer 110 which each of them comprises substantially connects said lateral faces 104 and 105 together. It will be understood that a tread 101 according to one of these Figs. 2a to 2d might for example be such that the conductive layer 110 which it comprises meets the aforementioned description with reference to Figs. 1a and 1b.

[0064] More precisely, the tread 101 of Fig. 2a differs from that of Fig. 2 in that it comprises between its lateral faces 104 and 105, instead of said films 114, two conductive films 114' which electrically connect the inner and outer faces 102 and 103 of said tread 101 together.

[0065] These two films 114' in this example are symmetrical to each other relative to the circumferential median plane P of this tread 101.

[0066] It will be noted that a tread 101 in accordance with this variant embodiment might comprise more than two conductive films 114', and that each film 114' might have a given inclination other than that shown in Fig. 2a, relative to said circumferential median plane P.

[0067] As for the tread 101 of Fig. 2c, it differs from that of Fig. 2a in that it comprises between its lateral faces 104 and 105 a single conductive film 114' which connects said faces 102 and 103 together, in this example provided at the location of said median plane P.

[0068] The tread 101 of Fig. 2b differs from that of Fig. 2 in that it comprises, firstly, two inner conductive strips 114a which are provided respectively at the locations of said lateral faces 104 and 105 and which connect said conductive layer 110 to said inner face 102 and, secondly, an outer conductive strip 114b which is provided between said lateral faces 104 and 105 and which connects said layer 110 to said outer face 105.

[0069] In the example of Fig. 2b, said outer strip 114b is provided at the location of said circumferential median plane P.

[0070] It will however be noted that a tread 101 in accordance with this variant embodiment might comprise one or more outer strips 114b, each possibly having a different geometry and inclination from said plane P, provided that it connects said layer 110 to said outer face 105.

[0071] As for the tread 101 of Fig. 2d, it also comprises an external strip 114b such as that of Fig. 2b, but differs from that of Fig. 2b in that it comprises a single inner strip 114 which connects said inner face 102 to said conductive layer 110, said inner strip 114a being provided between said lateral faces 104 and 105.

[0072] It will be noted that these conductive films 114' and strips 114a and 114b may have a different thickness from that of said or each conductive layer 110.

[0073] As for the resistivity of said films 114' and said strips 114a and 114b, it is preferably substantially equal to that of said layer 110 in these variant embodiments.

EXAMPLES

[0074] An account will now be given of tests carried out, firstly, with a first set of tires having a tread 1 according to Fig. 1 and, secondly, with a second set of tires having a tread

101 according to Fig. 2. These tests were performed in comparison with a "control" set of tires, which is characterised by an insulating tread having a resistivity greater than or equal to 10^{13} Ω.cm.

[0075] These tests consisted in quantifying the radio interference detected in amplitude-modulation mode, during the travel of a test vehicle provided successively with these sets of tires, by amplification and analysis of the corresponding recorded signals on a loudspeaker.

[0076] These tests were carried out under the same weather conditions (temperature: 17°C, moisture content of the external air: 18%, dewpoint temperature of the external air: -7°C) and under the same travelling conditions (road sections comprising manhole covers, travelling speed: 70 km/h).

[0077] Furthermore, there was used for the radio receiver on board the test vehicle a frequency of 1386 kHz, corresponding to amplitude modulation, with the same amplification of the signal emitted from the radio receiver for all the tests.

[0078] The tires of each of the sets tested had a tread of a thickness of about 1.2 cm. Relating to the tires having a tread 1, 101 according to the invention which are relative to said first and second sets, each axial conductive layer 10, 110 had a thickness of 0.5 mm and a resistivity substantially equal to 10^3 Ω.cm.

[0079] Relating to the tread 101 of the tires of said second set, the two radial conductive layers 114 for example had a thickness of 0.5 mm, and a resistivity which is likewise less than or equal to 10^3 Ω.cm.

[0080] As for the resistivity of said insulating material of each tread 1, 101, it was made equal to that of each tread of said "control" set, that is to say, greater than or equal to 10^{13} Ω.cm.

[0081] The results of these tests are illustrated by the graphs of Figs. 3, 4 and 5, which refer respectively to said "control" set, to said first set and to said second set of tires, and which

represent average values, over several runs, of the potential of the signal recorded in amplitude-modulation mode (expressed in V) as a function of time (expressed in ms).

[0082] It can be seen in Fig. 3 that, for the "control" set of tires, the travelling of the vehicle over the metal elements generates at the loudspeaker average values of interference of relatively high amplitudes (1.62 V and 1.79 V, for the front and rear pairs of tires respectively). These average potential values, referred to as "V_{rms}" by the person skilled in the art, are calculated by means of discrete root mean square over an acquisition time window.

[0083] As can be seen in Fig. 4, the first set of tires according to the invention itself generates average interference values V_{rms}, the amplitudes of which are very substantially reduced compared with said "control" set (0.66 V and 0.72 V, for the front and rear pairs of tires respectively, or a reduction of about 60%).

[0084] As can be seen in Fig. 5, the second set of tires according to the invention generates average interference values V_{rms}, the amplitudes of which are reduced still further compared with said first set (0.16 V and 0.21 V, for the front and rear pairs of tires respectively, or a reduction of about 90%).

[0085] As can be seen in Figs. 4 and 5, it will be noted that the duration of each interference phenomenon relative to said first and second sets of tires is likewise substantially reduced relative to the "control" set.

[0086] In conclusion, the result of these tests shows satisfactory listening comfort for the passenger or passengers in a vehicle which is equipped with tires according to the invention.